Morphological and Seed Set Characteristics of Centipedegrass Accessions Collected in China[1]

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Liu, J. *(Nanjing Botanical Gardens, Nanjing 210014 PRC),* **W. Hanna** *(USDA-ARS, Tifton, GA 31793), and* **E. Elsner** *(Georgia Seed Development Commission, Athens, GA 30605).* Morphological and Seed Set Characteristics of Centipedegrass Accessions Collected in China. *Economic Botany 57(3):05em, 2003. Greater than two-fold differences were observed between the lowest and highest means for stolon number and length characteristics. A 60% difference in total length was observed between the longest stolon of accessions. There was a 42% difference between the accessions with the fastest and slowest growing stolons. Accession with the longest and shortest internode differed by 28%. Small differences were observed for leaf length and width. Seed set under selfing was less than 7% indicating high self-incompatibility. Open-pollinated seed set ranged from 37% to 87%. Coefficients of variation for the various characteristics measured indicate that the Chinese accessions should provide more variation for genetic improvement in this species. Data showed that measuring total stolon length at five weeks after transplanting was adequate for evaluating all of the stolon length and number characteristics in this study. The Chinese accession appear to be a valuable source of new germplasm for this species.*

Key Words: germplasm; turf; *Eremochloa ophiuroides.*

Centipedegrass [*Eremochloa ophiuroides* (Munro) Hack] is a warm-season turfgrass, light green in color. It grows well on a wide range of soil types. Centipedegrass requires less management and fertilization to produce an acceptable turf than most warm season turfgrasses, therefore it has tremendous potential for expanded use for lawns, landscaping, roadsides, and recreational fields in tropical and subtropical areas around the world (Hanna 1995).

Centipedegrass is indigenous to Southeast Asia (Hanson et al. 1969). It is generally assumed that China is the area of origin for this species because large areas of natural centipedegrass can be found from central to southern China.

Centipedegrass was introduced into the USA from a 1916 plant exploration trip by Frank Meyer. 'Common' centipedegrass growing in the USA is assumed to have originated from this accession (Hanson et al. 1969). Centipedegrass has become a popular lawn grass mainly in the southeastern USA. Its northern limit is about 35°N latitude in the USA. Centipedegrass is not widely used as cultivated turf outside the USA, even in the area of presumed origin.

Limited morphological variation has been reported in centipedegrass. Bouton et al. (1983) found variation in stem node color and various enzymes. Limited morphological variation was observed in 31 accessions collected mainly from Taiwan (Hanna 1995). Only two improved, seed-propagated cultivars, 'Oaklawn' and 'TifBlair' (Hanna 1995) and two vegetatively propagated cultivars, 'TennTurf' (Callahan 1999) and 'AU Centennial' (Pedersen and Dickens 1995) have been released. Green and Beard (1991) reported similar turf quality for the released cultivars (except 'TifBlair' was not released, nor included) based on six years of continuous assessment. DNA amplification fingerprinting and hybridization analysis indicated that these cultivars ('TifBlair' was not included) are closely related and are from a common origin, i.e., 'Common' (Weaver et al. 1995). It is assumed that the limited morphological variation is probably due to the narrow gene base of centipedegrass in the USA.

To broaden the centipedegrass germplasm base in the USA, a systematic germplasm collecting trip was made in central and southern

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TABLE 1. THE LOCATION OF CENTIPEDEGRASS ACCESSIONS STUDIED IN THIS EXPERIMENT.

Entry† (TC)	Location (city), Province	Latitude	Longitude	Elevation (m)	Soil pH
327‡	Fuzhou, Fujian	28°03′N	119°21′E	/	/
350‡	Chuzhou, Anhui	32°22′N	118°08′E	/	6.5
351‡	Chuzhou, Anhui	32°22′N	118°08′E	/	6.5
352	Chuzhou, Anhui	32°21′N	118°08′E	/	7.1
353‡	Changsha, Hunan	28°12′N	113°06′E	70	6.9
354	Changsha, Hunan	28°11′N	113°07′E	235	7.1
355	Changsha, Hunan	28°08′N	113°07′E	66	7.0
356‡	Changsha, Hunan	28°10′N	112°50′E	36	/
357	Changsha, Hunan	28°09′N	113°07′E	75	/
358	Changsha, Hunan	28°09′N	112°49′E	89	4.8
359‡	Changsha, Hunan	28°12′N	112°44′E	35	5.1
360‡	Changsha, Hunan	28°14′N	112°38′E	70	4.5
361	Changsha, Hunan	28°14′N	112°30′E	109	/
362‡	Changsha, Hunan	28°16′N	112°31′E	145	/
363	Changsha, Hunan	28°20′N	112°30′E	138	/
364‡	Changsha, Hunan	28°24′N	112°28′E	105	/
365	Guangzhou, Guangdong	23°17′N	113°39′E	44	6.2
366	Guangzhou, Guangdong	23°13′N	113°59′E	70	5.8
368	Guangzhou, Guangdong	23°14′N	114°09′E	64	4.9
369	Guangzhou, Guangdong	23°21′N	114°18′E	112	5.0
370	Guangzhou, Guangdong	23°34′N	114°36′E	78	6.6
371	Guangzhou, Guangdong	23°19′N	114°27′E	62	/
372‡	Guangzhou, Guangdong	23°03′N	114°28′E	70	/
373	Guangzhou, Guangdong	22°55′N	148°38′E	85	/
374‡	Guangzhou, Guangdong	/	/	/	/
375‡	Guiyang, Guizhou	26°28′N	106°40′E	1243	/
376	Guiyang, Guizhou	26°25′N	106°40′E	1188	7.5
377‡	Guiyang, Guizhou	26°32′N	106°47′E	1084	6.9
378	Guiyang, Guizhou	26°31′N	106°51′E	1285	7.1
379	Guiyang, Guizhou	26°29′N	106°54′E	1250	6.1
380	Guiyang, Guizhou	26°28′N	106°56′E	/	6.9
381‡	Guiyang, Guizhou	26°27′N	107°01′E	1061	/
382	Guiyang, Guizhou	26°28′N	107°08′E	1025	6.1
383	Guiyang, Guizhou	26°35′N	106°37′E	1198	7.2
384‡	Guiyang, Guizhou	26°37′N	106°37′E	1298	/
385	Guiyang, Guizhou	26°35′N	106°34′E	1269	7.6
386	Guiyang, Guizhou	26°33′N	106°28′E	1210	7.6
387	Chengdu, Sichuan	30°25′N	103°49′E	440	7.5
388	Chengdu, Sichuan	30°25′N	103°48′E	443	7.4
389‡	Chengdu, Sichuan	30°24′N	103°41′E	460	/
390	Xingyang, Henan	32°03′N	118°28′E	/	/
391‡	Xingyang, Henan	31°51′N	117°04′E	80	5.8
392	Xingyang, Henan	31°45′N	116°06′E	79	6.3
393‡	Xingyang, Henan	32°10′N	115°37′E	143	7.3
394‡	Xingyang, Henan	32°11′N	114°03′E	189	7.0
395‡	Xingyang, Henan	32°18′N	114°01′E	188	/
396‡	Xingyang, Henan	32°25′N	114°01′E	/	7.4
397‡	Xingyang, Henan	32°35′N	113°58′E	160	6.9
398‡	Xingyang, Henan	32°43′N	113°59′E	112	/
399‡	Xingyang, Henan	32°08′N	114°01′E	/	7.0
400‡	Xingyang, Henan	31°57′N	114°05′E	182	/
401‡	Xingyang, Henan	31°51′N	114°04′E	215	7.0
402‡	Xingyang, Henan	32°11′N	114°33′E	83	6.6

TABLE 1. CONTINUED.

Entry† (TC)	Location (city), Province	Latitude	Longitude	Elevation (m)	Soil pH
403‡	Nanjing, Jiangsu	32°32′N	118°48′E	/	/
404‡	Nanjing, Jiangsu	32°32′N	118°48′E	/	/
405	Nanjing, Jiangsu	32°32′N	118°48′E	/	/
406‡	Nanjing, Jiangsu	32°32′N	118°48′E	36	6.7
407‡	Nanjing, Jiangsu	32°32′N	118°48′E	36	6.8

† Tifton centipedegrass (TC) accession number.
‡ The 31 accessions used for the morphological variation analyses.

China in the autumn of 1999. The purpose of this study was to assess some of the morphological variation present in 31 accessions and seed set variation in 58 accessions representing the six regions where this species was collected. Accessions collected in China are compared to the standard cultivars, 'Common' and 'TifBlair'.

MATERIALS AND METHODS

Centipedegrass seeds were collected in September and October 1999 from 62 sites representing six geographical regions (Table 1) in China. Plants were established from seeds collected at 58 sites. Thirty-one of these sites representing the six geographical regions produced enough plants from the originally collected seeds to perform a replicated study to begin assessing morphological variation (Table 2). 'TifBlair' and 'Common' were used as controls.

Fifty single plant replications of the 33 accessions were arranged in a randomized complete block design. Single plants established in 5 cm pots in the greenhouse were planted on 0.9 m center in the field on 19 May 2000 in a Clarendon loamy sand (fine-loamy, siliceous, Thermic Plinthequic Paleudults) with pH 6.0.

The plot area was fumigated with 1.8 kg methyl bromide per 92.9 m^2 before plants were transplanted to the field. The plot area received 537 kg/ha of a 10:10:10 (N:P:K) fertilizer and 112 kg ha^{-1} ammonium nitrate fertilizer.

Measurements were initiated one month after the plots were established. The following characteristics were measured:

1) Total number of stolons on 12 June (TNS1) and 26 June (TNS2).
2) Rate of stolon number increase (RSN) calculated as the difference between TNS1 and TNS2.
3) Total length of stolons (cm) on 14–19 June (TLS1) and on 5–13 July (TLS2).
4) Rate of total stolon length increase (RSL) in cm calculated as the difference between TLS1 and TLS2.
5) Length (cm) of the longest stolon on 14–19 June (LLS1) and on 5–13 July (LLS2).
6) Rate of stolon growth in length (RSGL) (cm) calculated by marking with a stake the end of a medium length random stolon from each plant on 30 June. Growth was measured on 14–15 July (two weeks later).
7) Length (cm) of first fully exposed internode (LFEI) from growing point—measured on a medium length stolon.
8) Width (cm) of mature leaf (WML)—measured in center of plant canopy.
9) Length (cm) of mature leaf (LML)—measured in the center of plant canopy.
10) Inflorescence length (IL) in cm.
11) Number of florets (FN) per inflorescence.
12) Open-pollinated (OP) and selfed (S) seed set.

Selfed seed set was determined from 5 to 10 inflorescences bagged with small kraft bags in each plot before anthesis. OP seed set was determined from 10 non-bagged inflorescences within each plot. Seed set was determined from random inflorescences in 1.5 m × 1.5 m maintenance plots that had been established from 20 or more original accession plants. Seed set, inflorescence length (IL), and floret number (FN) were determined on all 58 accessions. 'Common' and 'TifBlair' were not included in the analyses of seed set, IL and FN data because these two cultivars were not included in the maintenance nursery plots.

The morphological and seed set characteristics were analyzed by analysis of variance procedures (SAS Institute, Inc. 1985). Separation of means was determined by least significance dif-

TABLE 2. MEANS FOR MORPHOLOGICAL CHARACTERISTICS OF CENTIPEDEGRASS ENTRIES OBSERVED IN 2000.†

Entry TC	Total number of stolon			Total length of stolon			Length of longest stolon					
	TNS1	TNS2	RSN	TLS1	TLS2	RSL	LLS1	LLS2	RSGL	LFEI	WML	LML
						cm					mm	cm
327	6.2	14.5	8.3	178	1314	1146	37	93	36	2.8	0.42	5.8
	(0–14)‡	(5–33)	(1–19)	(40–445)	(257–2886)	(203–2534)	(19–75)	(55–160)	(27–52)	(2.1–3.5)	(0.30–0.40)	(3.5–9.5)
350	5.0	12.2	7.2	138	985	885	30	81	35	2.6	0.44	5.6
	(0–10)	(2–23)	(1–17)	(17–284)	(179–2391)	(143–2107)	(9–50)	(50–120)	18–43)	(2.0–3.2)	(0.35–0.55)	(2.7–8.9)
351	5.1	11.1	6.1	141	835)	715	28	74	33	2.3	0.45	5.3
	(1–10)	(3–20)	(0–16)	(28–276)	(105–1491)	(54–1811)	(14–47)	(40–120)	(25–44)	(1.6–3.1)	(0.35–0.57)	(2.7–9.7)
353	4.2	10.1	5.8	117	789	675	28	73	33	2.5	0.46	5.0
	(1–8)	(4–21)	(0–16)	(13–307)	(152–1662)	(116–1421)	(11–47)	(32–100)	(20–45)	(1.7–3.2)	(0.35–0.60)	(3.2–9.2)
356	6.2	14.4	8.2	183	1139	962	32	78	33	2.5	0.46	5.0
	(1–12)	(4–30)	(0–21)	(22–384)	(234–2451)	(206–2196)	(11–47)	(40–110)	(20–44)	(1.7–3.0)	(0.3–0.6)	(3.2–9.2)
359	7.5	17.2	9.8	221	1324	1106	32	78	31	2.2	0.46	4.8
	(3–15)	(6–37)	(1–27)	(59–572)	(401–3238)	(292–2846)	(17–56)	(43–110)	(18–43)	(1.6–2.9)	(0.30–0.55)	(2.5–7.6)
360	6.4	14.4	8.2	186	1025	846	31	73	31	2.3	0.45	5.0
	(1–12)	(5–32)	(2.24)	(27–398)	(174–2302)	(123–2058)	(18–51)	(42–100)	(26–40)	(1.5–3.2)	(0.35–0.55)	(2.0–7.8)
362	5.3	12.8	7.5	160	992	839	32	77	31	2.4	0.45	4.8
	(0–12)	(3–25)	(0–19)	(6–356)	(132–2763)	(124–2494)	(6–57)	(28–110)	(17–42)	(1.6–3.0)	(0.35–0.65)	(2.8–7.4)
364	3.9	10.8	6.8	113	778	674	26	70	32	2.3	0.45	5.4
	(0–8)	(2–21)	(1–15)	(10–256)	(112–1771)	(92–1551)	(7–47)	(35–110)	(22–45)	(1.5–3.3)	(0.30–0.55)	(2.7–9.0)
372	7.1	18.5	11.2	219	1474	1248	37	88	34	2.5	0.42	4.3
	(1–15)	(4–39)	(2–25)	(45–482)	(452–2667)	(402–2311)	(22–57)	(52–130)	(27–42)	(1.5–3.2)	(0.30–0.55)	(2.7–6.5)
374	6.3	14.1	7.8	179	1169	997	35	87	34	2.5	0.44	5.1
	(2–16)	(3–26)	(0–18)	(35–459)	(275–2090)	(217–2090)	(19–48)	(50–135)	(23–54)	(1.8–3.6)	(0.35–0.60)	(3.2–8.4)
375	6.0	15.1	9.1	182	1085	905	31	77	33	2.5	0.43	4.8
	(2–13)	(5–30)	(0–20)	(33–559)	(185–2394)	(106–1882)	(17–54)	(34–120)	(21–39)	(1.7–3.2)	(0.35–0.60)	(3.2–7.8)
377	6.0	14.4	8.4	176	1012	838	33	77	30	2.5	0.44	4.9
	(1–11)	(4–30)	(0–20)	(28–326)	(259–1947)	(163–1746)	(12–57)	(40–110)	(20–40)	(1.5–3.5)	(0.30–0.55)	(1.8–7.8)
381	5.6	13.0	7.4	153	827	682	30	67	29	2.3	0.44	4.7
	(2–12)	(5–24)	(1–20)	(60–397)	(240–2181)	(143–1869)	(19–46)	(32–110)	(18–37)	(1.6–3.3)	(0.35–0.60)	(2.7–7.8)
384	8.2	19.1	11.0	236	1363	1132	32	74	30	2.4	0.43	4.9
	(3–17)	(8–33)	(2–24)	(62–539)	(246–2601)	(184–2335)	(15–51)	(46–110)	(20–49)	(1.6–3.4)	(0.30–0.55)	(3.0–8.0)
389	4.1	8.9	4.8	93	487	414	23	57	26	2.2	0.44	4.7
	(0–10)	(1–16)	(0–13)	(0–286)	(20–1003)	(69–907)	(11–40)	(20–82)	(15–38)	(1.5–3.5)	(0.30–0.60)	(1.7–7.6)
391	5.0	12.5	7.5	137	897	765	27	73	31	2.4	0.42	4.6
	(1–9)	(4–33)	(0–24)	(10–294)	(163–2375)	(121–2093)	(10–46)	(40–110)	(16–46)	(1.6–3.2)	(0.30–0.55)	(2.7–9.8)

TABLE 2. CONTINUED.

Entry TC	Total number of stolon			Total length of stolon			Length of longest stolon					
	TNS1	TNS2	RSN	TLS1	TLS2	RSL	LLS1	LLS2	RSGL	LFEI	WML	LML
393	4.9	11.9	7.1	149	904	760	32	79	31	2.5	0.44	4.7
	(1–9)	(5–23)	(0–18)	(34–325)	(116–1703)	(82–1522)	(12–56)	(21–110)	(17–50)	(1.8–3.4)	(0.5–0.55)	(2.7–8.0)
394	4.7	11.9	7.1	144	907	765	31	79	35	2.6	0.43	5.2
	(1–9)	(3–31)	(1–22)	(19–390)	(259–2081)	(240–1706)	(16–63)	(50–120)	(26–46)	(1.7–3.5)	(0.35–0.60)	(2.7–9.0)
395	4.4	11.8	7.4	133	835	698	28	71	31	2.4	0.45	5.1
	(0–10)	(4–22)	(0–17)	(12–305)	(167–1816)	(136–1608)	(8–45)	(40–110)	(18–42)	(1.9–3.2)	(0.37–0.60)	(2.5–9.0)
396	4.5	12.3	7.8	132	900	770	27	71	31	2.5	0.41	5.0
	(0–9)	(2–25)	(2–21)	(0–339)	(53–1926)	(53–1731)	(13–46)	(23–110)	(15–46)	(1.8–3.2)	(0.30–0.50)	(2.3–8.0)
397	4.7	12.6	7.9	160	1002	842	33	81	34	2.7	0.44	5.2
	(1–9)	(4–33)	(1–25)	(22–514)	(332–2279)	(247–1977)	(17–55)	(50–112)	(20–43)	(1.8–4.5)	(0.35–0.53)	(2.3–9.3)
398	4.6	12.4	7.8	149	956	818	31	79	36	2.6	0.44	4.8
	(1–11)	(4–32)	(2–21)	(22–507)	(248–2303)	(167–1924)	(11–63)	(35–150)	(28–44)	(1.7–3.4)	(0.35–0.55)	(2.7–11.2)
399	4.5	11.8	7.4	131	884	776	29	77	32	2.5	0.45	4.9
	(0–10)	(1–25)	(0–17)	(16–463)	(68–2007)	(50–1862)	(8–45)	(31–120)	(15–43)	(1.7–3.4)	(0.30–0.57)	(2.5–7.8)
400	5.0	15.7	10.5	186	1137	957	33	82	33	2.6	0.43	5.3
	(2–10)	(3–27)	(0–22)	(31–469)	(115–2121)	(84–1927)	(12–52)	(35–130)	(15–43)	(1.7–3.5)	(0.35–0.53)	(2.7–9.9)
401	5.0	12.4	7.4	157	943	794	36	88	34	2.7	0.45	5.3
	(1–12)	(1–21)	(0–16)	(27–432)	(147–2322)	(114–2070)	(19–70)	(52–150)	(27–43)	(1.8–3.4)	(0.30–0.60)	(3.2–7.5)
402	5.0	12.9	7.9	151	928	785	29	76	33	2.5	0.43	5.1
	(0–14)	(4–28)	(2–22)	(14–478)	(116–2222)	(102–2002)	(14–50)	(40–115)	(22–44)	(1.6–3.0)	(0.35–0.50)	(2.7–9.2)
403	5.3	13.1	7.7	165	950	787	30	76	33	2.4	0.43	5.3
	(0–10)	(5–27)	(1–21)	(22–341)	(197–1849)	(162–1659)	(12–45)	(45–110)	(23–45)	(1.6–3.4)	(0.35–0.57)	(2.5–8.5)
404	5.2	14.1	8.9	161	1102	944	31	81	34	2.4	0.44	4.7
	(1–11)	(5–30)	(2–23)	(0–385)	(270–2908)	(206–2533)	(10–51)	(45–150)	(20–52)	(1.7–3.2)	(0.35–0.55)	(2.3–7.4)
406	5.3	13.2	7.8	158	939	799	30	75	33	2.4	0.44	4.8
	(2–9)	(4–24)	(1–18)	(27–322)	(219–2018)	(192–1787)	(12–47)	(35–116)	(22–45)	(1.6–3.0)	(0.35–0.55)	(3.4–9.7)
407	5.2	11.4	6.2	150	903	745	31	81	33	2.3	0.42	5.1
	(1–10)	(4–22)	(0–18)	(27–392)	(280–1667)	(230–1456)	(16–53)	(37–125)	(18–46)	(1.5–4.0)	(0.30–0.50)	(3.0–11)
COM	6.5	15.8	9.3	206	1340	1142	34	90	37	2.7	0.45	5.9
	(1–12)	(4–28)	(0–21)	(22–503)	(296–2369)	(274–2042)	(13–52)	(60–140)	(28–46)	(2.0–3.4)	(0.32–0.60)	(3.4–12)
TB	6.1	15.0	8.8	191	1173	987	35	89	35	2.6	0.46	5.6
	(1–11)	(4–29)	(0–22)	(31–438)	(252–2209)	(176–1905)	(16–60)	(44–145)	(27–45)	(2.0–3.7)	(0.35–0.57)	(3.4–9.0)
LSD (0.05)	0.9	2.0	1.7	28	166	149	3	6	3	0.1	0.02	0.5
CV (%)	40.8	38.9	52.3	44.2	41.7	44.2	23.0	19.1	13.1	16.7	11.4	25.5

† TNS1 = total number of stolon for each plant on June 12; TNS2 = total number of stolons for each plant on June 26; RSN = rate of stolon growth in number, TLS1 = total length of stolon for each plant on June 14–19; TLS2 = total length of stolon for each plant on July 5–13; RSL = rate of total stolon growth in length; LLS1 = length of longest stolon for each plant on June 14–19; LLS2 = length of longest stolon for each plant on July 5–13; RSGL = the rate of stolon growth in length; LFEI = length of first fully exposed internode; WML = width of matured leaf; LML = length of matured leaf.

‡ = Range.

TABLE 3. MEAN INFLORESCENCE AND SEED-SET CHARACTERISTICS OF CENTIPEDEGRASS ACCESSIONS FROM CHINA.†

Entry (TC)	IL	FN	SS1	SS2
327	4.9	17.6	87	0
	(4.4–5.5)‡	(14–22)	(73–94)	
350	5.0	18.1	50	0
	(4.2–6.5)	(13–22)	(0–92)	
351	4.8	19.0	55	2
	(4.4–5.4)	(15–21)	(0–82)	(0–6)
352	5.1	17.4	60	1
	(4.5–5.7)	(15–22)	(16–88)	(0–7)
353	4.5	18.6	58	1
	(4.0–5.4)	(16–23)	(10–94)	(0–6)
354	4.5	19.0	72	0
	(3.7–5.1)	(16–23)	(37–89)	
355	4.7	17.8	66	4
	(4.1–5.3)	(13–21)	(43–91)	(0–11)
356	5.0	20.3	46	2
	(4.3–6.4)	(16–24)	(5–88)	(0–14)
357	5.1	18.3	63	0
	(4.4–6.0)	(15–21)	(22–89)	
358	4.5	19.9	63	3
	(3.9–5.5)	(17–24)	(20-95)	(0–6)
359	4.5	17.6	68	2
	(3.8–5.2)	(13–22)	(36–100)	(0–5)
360	4.8	20.1	62	1
	(3.7–5.3)	(14–23)	(18–85)	(0–5)
361	4.6	17.5	57	0
	(3.9–5.4)	(14–19)	(11–94)	
362	4.5	17.6	57	1
	(3.4–5.0)	(15–22)	(31–87)	(0–6)
363	4.9	17.6	79	0
	(4.3–5.8)	(15–21)	(53–95)	
364	4.8	16.9	52	1
	(4.1–5.2)	(14–19)	(11–89)	(0–6)
365	4.8	17.9	61.7	0
	(4.2–5.2)	(15–20)	(30–100)	
366	4.7	17.9	46	0
	(4.0–5.1)	(16–21)	(24–69)	
368	4.7	19.5	41	0
	(4.3–5.2)	(18–22)	(11–95)	
369	5.0	18.6	65	2
	(4.4–6.0)	(17–20)	(0–90)	(0–11)
370	5.2	19.0	58	0
	(4.8–5.7)	(17–21)	(5–95)	
371	4.9	18.8	49	0
	(4.4–5.1)	(17–22)	(0–95)	
372	4.9	20.4	83	0
	(4.0–5.9)	(17–25)	(47–100)	
373	4.3	18.2	64	0
	(3.8–4.8)	(16–20)	(17–85)	
374	5.2	18.5	60	0
	(4.5–5.8)	(14–22)	(33–93)	
375	5.4	19.5	50	2
	(4.7–5.9)	(18–23)	(5–90)	(0–11)

ference (LSD). Association among traits was calculated by the CORR procedure, which estimates phenotypic (Pearson) correlations. Reference to significance in the manuscript means $P \leq 0.05$.

RESULTS AND DISCUSSION

'TifBlair' and 'Common' were similar for most of the morphological characteristics measured in this study. Significant differences observed were small and probably of little practical significance. This is not too surprising because 'TifBlair' was derived from 'Common' and selected for resistance to cold and low soil pH and not morphological characteristics. However, large morphological differences were observed among the accessions in this study (Table 2), indicating potential for selecting useful variation.

STOLON NUMBER

Number of stolons at the first measuring date (TNS1) ranged from 3.9 for TC364 to 8.2 for TC384. At the second measuring date (TNS2) stolon numbers ranged from 8.9 for TC389 to 19.1 for TC384. Rate of increase in stolon production (RS) ranged from 4.8 for TC389 to 11.2 for TC372. Greater than two-fold differences were observed between accessions with the lowest and highest values.

TC359 and TC 384 were the only entries with significantly more stolons than 'Common' at TNS1, whereas, these two and TC372 had more stolons than 'TifBlair' at TNS1. At TNS2, TC372 and TC384 had more stolons than 'Common'. TC359, TC372 and TC384, had more stolons than 'TifBlair' at TNS2. TC372 and TC384 produced significantly more stolons between TNS1 and TNS2 than both 'Common' and 'TifBlair'.

Twenty-two and 20 accessions produced fewer stolons than 'Common' and 18 and 17 accessions produced fewer stolons than 'TifBlair' for TNS1 and TNS2, respectively. These data indicate that progress can be made in selecting for genotypes that produce more stolons than the current cultivars. It is a little discouraging that more accessions (except for TC359, TC372 and TC384) were not higher stolon producers than 'Common' and 'TifBlair'. However, this was not entirely unexpected because the new accessions have not been specifically selected for stolon production, a desirable characteristic. 'Common'

TABLE 3. CONTINUED.

Entry (TC)	IL	FN	SS1	SS2
376	5.5	19.6	53	0
	(4.8–6.4)	(17–22)	(9–82)	
377	5.5	19.1	62	0
	(4.7–6.4)	(14–22)	(0–85.0)	
378	5.1	18.3	63	2
	(4.4–5.7)	(16–22)	(35–95)	(0–5)
379	5.2	18.6	42	0
	(3.6–6.2)	(14–22)	(0–90.0)	
380	4.6	17.7	70	0
	(3.9–6.0)	(14–22)	(0–88.9)	
381	4.7	17.9	73	4
	(4.4–5.5)	(16–21)	(25–95)	(1–11)
382	5.1	18.6	81	2
	(4.3–5.7)	(15–21)	(72–95)	(1–6)
383	4.9	17.6	51	0
	(4.2–6.0)	(13–23)	(13–83)	
384	4.7	18.0	68	2
	(4.3–5.4)	(15–20)	(45–89)	(0–13)
385	4.7	16.6	81	0
	(4.2–5.8)	(15–18)	(44–100)	
386	4.9	18.0	48	0
	(4.5–5.5)	(14–21)	(5–81)	
387	5.1	19.8	46	0
	(3.5–6.3)	(17–22)	(10–72)	
388	3.6	16.8	43	4
	(3.1–4.2)	(15–19)	(24–67)	(0–11)
389	4.5	16.8	47	3
	(3.8–5.8)	(15–26)	(20–68)	(1–13)
390	5.2	19.6	51	1
	(4.1–6.4)	(17–22)	(5–88)	(0–6)
391	5.1	18.9	63	0
	(4.3–6.2)	(16–24)	(0–94)	
392	4.9	18.7	56	0
	(4.3–5.5)	(16–22)	(0–83)	
393	5.1	18.7	64	0
	(4.4–5.4)	(17–20)	(0–100)	
394	4.9	19.0	53	5
	(4.1–5.3)	(17–22)	(10–95)	(0–24)
395	5.0	18.3	54	0
	(4.2–5.4)	(15–21)	(0–100)	
396	5.2	19.0	52	0
	(4.4–5.9)	(16–25)	(12–90)	
397	4.8	18.6	37	2
	(4.5–5.8)	(16–21)	(0–100)	(0–21)
398	4.9	18.9	68	1
	(4.2–5.6)	(16–22)	(47–95)	(0–5)
399	4.9	17.9	55	3
	(3.7–5.9)	(15–20)	(25–76)	(0–16)
400	5.7	20.6	68	1
	(4.1–6.7)	(14–22)	(45–100)	(0–6)
401	5.1	18.8	64	2
	(4.7–5.8)	(17–20)	(22–89)	(0–5)
402	4.9	19.6	79	2
	(4.4–5.7)	(15–25)	(33–100)	(0–14)
403	5.6	18.2	53	0
	(5.0–6.6)	(15–20)	(15–94)	
404	5.7	19.8	69	7
	(5.3–6.0)	(17–22)	(41–89)	(0–17)
405	5.3	19.7	62	6
	(4.4–6.2)	(18–22)	(28–81)	(0–24)
406	5.5	20.3	67	0
	(4.8–6.2)	(17–25)	(38–100)	
407	4.9	17.5	67	3
	(4.1–6.1)	(15–20)	(20–100)	(0–14)
COM	4.3	16.4	95	7
	(3.8–4.8)	(14–19)	(88–100)	(0–19)
TB	4.2	16.1	92	8
	(3.7–4.4)	(13–20)	(65–100)	(0–25)
LSD	0.5	1.9	20	5
CV (%)	10.4	11.5	36.4	264.7

† IL = inflorescence length; FN = number of florets for each inflorescence; SS1 = seed set (%) for open-pollinated inflorescences; SS2 = seed set (%) for selfed inflorescence.
‡ = Range.

and 'TifBlair' have had direct and indirect selection for more than 50 years for desirable plant types which probably included stolon number.

TOTAL STOLON LENGTH

Total stolon length per plant ranged from 93 cm for TC389 to 236 cm for TC384 at TLS1 and from 487 cm for TC389 to 1474 cm for TC372 at TLS2. Rate of stolon length change (RSL) ranged from 414 cm for TC389 to 1248 cm for TC372. Greater than 2.5-fold differences were observed between accessions with the lowest and highest values.

Accessions with the highest stolon number also tended to have the most total stolon length (TSL). TC359 and TC 384 produced more stolon growth in TLS1 than either 'Common' or 'TifBlair'. At TSL2, TC372 and TC384 produced more growth than 'TifBlair', but no accession produced more growth than 'Common'. No accession had a greater RSL than 'Common', but RSL for TC327 and TC372 was greater than for 'TifBlair'. Observations of the accessions for this characteristic is somewhat expected based on the observations on stolon number. Accessions with the most stolons had the highest total stolon length, e.g., TC352, TC372, and TC384. The exception is TC327. This accession had a greater stolon growth rate (RSGL)

TABLE 4. COEFFICIENTS OF VARIATION FOR MORPHOLOGICAL CHARACTERISTICS OBSERVED IN CENTIPEDEGRASS.

	Total no. of stolon			Total length of stolon								
Cultivar	TNS1	TNS2	RSN	TLS1	TLS2	RSL	LLS1	LLS2	RSGL	LFEI	WLM	LML
Com	34	35	53	44	34	36	25	19	12	12	11	31
Differ.	−27	−15	−7	−20	−38	−36	−8	−8	−43	−23	−6	19
TB	36	42	58	46	44	46	25	22	14	12	10	25
Differ.	−20	2	2	−14	−7	−8	−11	7	−25	−21	−12	−1
X‡	43	41	56	53	47	49	27	21	17	14	12	25

† The percent difference between the coefficient of variation for 'Common' or 'TifBlair' and that of all Chinese accessions.
‡ Average coefficient of variation for all Chinese accessions.

than most of the other accessions as will be seen later in this discussion.

LONGEST STOLON

The longest stolon ranged from 23 cm for TC389 to 37 cm for TC372 at LLS1 and from 57 cm for TC389 to 93 cm for TC327 at LLS2. The rate of growth of a stolon on a plant during a two week period (RSGL) ranged from 26 cm for TC389 to 37 cm for 'Common'.

No accession had a longer stolon at either LLS1 or LLS2 than 'TifBlair'. Only TC327 and TC372 had a longer stolon than 'Common' at LLS1. RSGL for TC327 was not significantly different than for 'Common' or 'TifBlair', but it was significantly higher than for TC359, TC372 and TC384, accessions with high stolon numbers and high total stolon length.

INTERNODE LENGTH

Length of the first fully exposed internode (LFEI) ranged from 2.2 cm for TC359 to 2.8 cm for TC327. No accession had a longer internode than 'Common' and only TC327 had a longer internode than 'TifBlair'. Twenty-six and 21 accessions had significantly shorter internodes than 'Common' and 'TifBlair', respectively, indicating potential for selecting types in the new germplasm that are more dwarf than the current cultivars.

LEAF LENGTH AND WIDTH

Leaf width (WML) ranged from 0.40 cm for TC 396 to 0.46 cm for TC353. Leaf length (LML) ranged from 4.3 cm for TC372 to 5.9 cm for 'Common'. No accessions had wider or longer leaves than 'Common' or 'TifBlair'. Twenty accessions had narrower and shorter leaves than 'TifBlair'. Six accession had narrower leaves and 29 accessions had shorter leaves than 'Common'. These observations indicate potential for selecting finer-textured plant types.

TABLE 5. PEARSON CORRELATION COEFFICIENTS FOR MORPHOLOGICAL CHARACTERISTICS OF CENTIPEDEGRASS.

Character	TNS1	TNS2	RSN	TLS1	TLS2	RSL	LLS1	LLS2	RSGL	LFEI	WML
TNS2	0.63*										
RSN	0.26*	0.91*									
TLS1	0.76*	0.73*	0.51*								
TLS2	0.59*	0.81*	0.70*	0.74*							
RSL	0.53*	0.77*	0.69*	0.66*	0.98*						
LLS1	0.42*	0.48*	0.37*	0.69*	0.59*	0.54*					
LLS2	0.31*	0.41*	0.35*	0.50*	0.65*	0.62*	0.66*				
RSGL	0.06	0.14*	0.14*	0.15*	0.31*	0.32*	0.27*	0.47*			
LFEI	0.02	0.07	0.07	−0.01	0.13*	0.14*	0.07	0.31*	0.37*		
WML	−0.08	−0.11*	−0.09	−0.09	−0.10*	−0.10*	−0.09	−0.07	0.03	0.07	
LML	0.04	0.10*	0.10*	0.11*	0.16*	0.16*	0.12*	0.19*	0.24*	0.16*	0.13*

* Significant at $P = 0.05$ level of probability (n = 1050~1637).

Head Length and Floret Number

Head length ranged from 3.6 cm for TC388 to 5.7 cm for TC 400 for a 1.6-fold difference between accessions with the shortest and longest inflorescences (Table 3). Floret number per inflorescence ranged from 16.6 for TC385 to 20.6 for TC400 or a 20% difference. There appears to be an opportunity to increase inflorescence length which could contribute to increased seed yield.

Seed Set

Selfed seed set ranged from 0% (29 accessions) to 7% TC404 (Table 3). Open-pollinated seed set ranged from 37% for TC 397 to 87% for TC327. These accessions appear to have a high level of self-incompatibility. Hanna and Burton (1978) found similar levels of self-incompatibility in centipedegrass. However, they found some accessions that set up to 58% selfed seed. The high self-incompatibility in these new Chinese accessions was not unexpected because poor seed set was observed on sparse inflorescence, due to heavy grazing by water buffalo at a number of the collection sites. It appears that self-incompatibility in this species is a mechanism for forced natural crossing to maintain diversity in this species. Selfed seed-set was 7% and 8% and OP seed-set was 95% and 92% for 'Common' and 'TifBlair', respectively, in an adjacent experiment with different management treatments.

Level of Variation in Germplasm

The differences between the coefficients of variation (CV) for 'Common' and the Chinese accessions tended to be higher than the CVs between 'TifBlair' and the Chinese accessions for the characteristics measured (Table 4). This could be due to the variation induced in 'TifBlair' through five generations of recurrent seed irradiation of 'Common' with cobalt-60 gamma-radiation (Hanna et al. 1997). The CVs for the Chinese accessions ranged from being 6% higher for leaf width (WML) to 42% higher for rate of stolon growth (RSGL) compared to 'Common'. 'Common' had more variation for leaf length (LML) than the Chinese accessions. The analyses indicate that the Chinese accessions should provide more variation for most of the characteristics measured. Additionally, the new accessions should provide new and diverse sources of variations which may be as important as level of variation.

Association Among Traits

Correlations between different traits are summarized in Table 5. The data shows a high correlation between TNS1 and TNS2 (r = 0.63). TNS2 shows as high or higher r-values with all of the stolon number and stolon length characters as TLS1 indicating that the total stolon length at five weeks after transplanting may be adequate to evaluate most of the stolon number and length characteristics. The rate of stolon growth (RSGL) may not be estimated by TNS2 because of a r-value of only 0.13. Internode length (LFEI) and leaf width (WML) and length (LML) did not appear to be highly correlated among themselves or with the other stolon number and length characteristics.

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